Module 4 – Post Processing

Support Material Types

Soluble Support

- Wash away in detergent bath
- Build internal cavities/channels
- Hands-free support removal
- Soluble core applications
- Retain feature detail without breaking

Break Away Supports (BASS)

- Break away supports manually
- No need for a tank
- Faster for simple support structures
- May not be able to reach all supports
- Hand tools required
- Can be time consuming

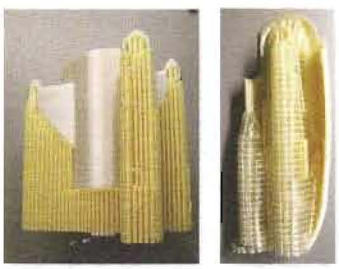
Support Removal

Support Removal - Soluble

- Tank agitation may be circulation or ultrasonic
- Temperature range
  - 70°C for SR-20 and SR-30
  - 80-85°C for SR100 or 70°C longer dissolve time
- Remove some support by hand to save tank time and water life span
- Keep parts submerged
- Enclosures for fragile parts
- Sparse parts
  - Parts will absorb water - add hole(s) for drainage
  - Parts will float - anchor to basket or tank

Support Removal - BASS

- Suggested tools shown
- May need to fabricate custom tools
- ULTEM and PPSF easier to remove if heated
  - ULTEM up to 160°C, PPSF up to 180°C
  - more heating/cooling cycles = support more difficult to remove
- Take care to not scratch or gouge part with tools
- Fragile parts - take your time



General Fixing Overview

- Filling voids
  - Open seams
  - Around holes
- Brown marks
  - Burnt material deposited in part by tip
  - Embedded support
- Light sanding or touch up
  - Edges, corners, seams
  - Use sandpaper or file
- Wisps of material
  - Hair-like appearance

Fixing - Voids

- Repairing open seams
  - Fill void with super glue
  - Blot with paper towel
  - Sprinkle baking soda over super glue
  - Repeat until void is filled and sand smooth

Alternate method

- Melt material into void and sand smooth
- Make paste with solvent and material

Fixing - Voids and Minor Brown Marks

- Repairing minor brown marks
  - Dig mark out of part
  - Fill void with super glue
  - Blot with paper towel
  - Sprinkle baking soda over super glue
  - Repeat until void is filled and sand smooth

Embedded/burned material

Alternate methods

- Fill with material by melting it into void (hot air welder)
- Make paste with solvent and material

Quality is critical for benchmarks. Best practice is to rebuild for a successful benchmark.

Fixing - Light Sanding

- Seams
  - Lightly sand or file to level the seam
  - File tends to work best
- Keep edges and corners clean
  - Touch up as needed with sand paper or file
  - File tends to work best
- Wisps or "hairs"
  - Melt with heat gun or hot air welder
  - Lightly sand to remove if needed

Bonding Methods Overview

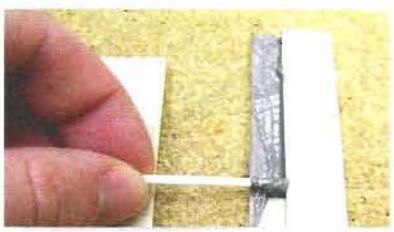
- Solvent
  - Joint is stronger than the part itself
  - Simple process
  - Clamp to hold in place until solvent cures
- Hot Air Welding
  - Very strong joint
  - More difficult technique - needs practice!
  - Usually no need for clamps and cure time
- Epoxy
  - Not as strong as other methods
  - Generally easy but can get messy
  - May need to clamp to hold for curing

Bonding - Solvents

- Align joint and clamp if needed
  - Make sure everything lines up
  - Clamp or spot tack part with super glue
- Apply solvent to joint
  - Using a brush or whatever you desire
  - Make sure joint is not over saturated
  - Securely clamp to avoid shifts
  - Allow to cure 8-12 hours
- Finish joint
  - Hand or power sand
  - Fill any remaining low spots using fixing methods
  - Allow to cure again and sand smooth

Bonding - Epoxy

- Match epoxy mechanical properties with material used
- Consider cure time and working time
- Most epoxies will cure faster if heat is applied
- Process
  - Mix well the two components - part A and part B
  - Apply with putty knife or similar tool
  - Clamp pieces together to hold in place
  - Wipe off excess epoxy with rag or paper towel
  - Allow to cure - heat may speed up curing process
  - Finish as desired



Bonding - Hot Air Welding

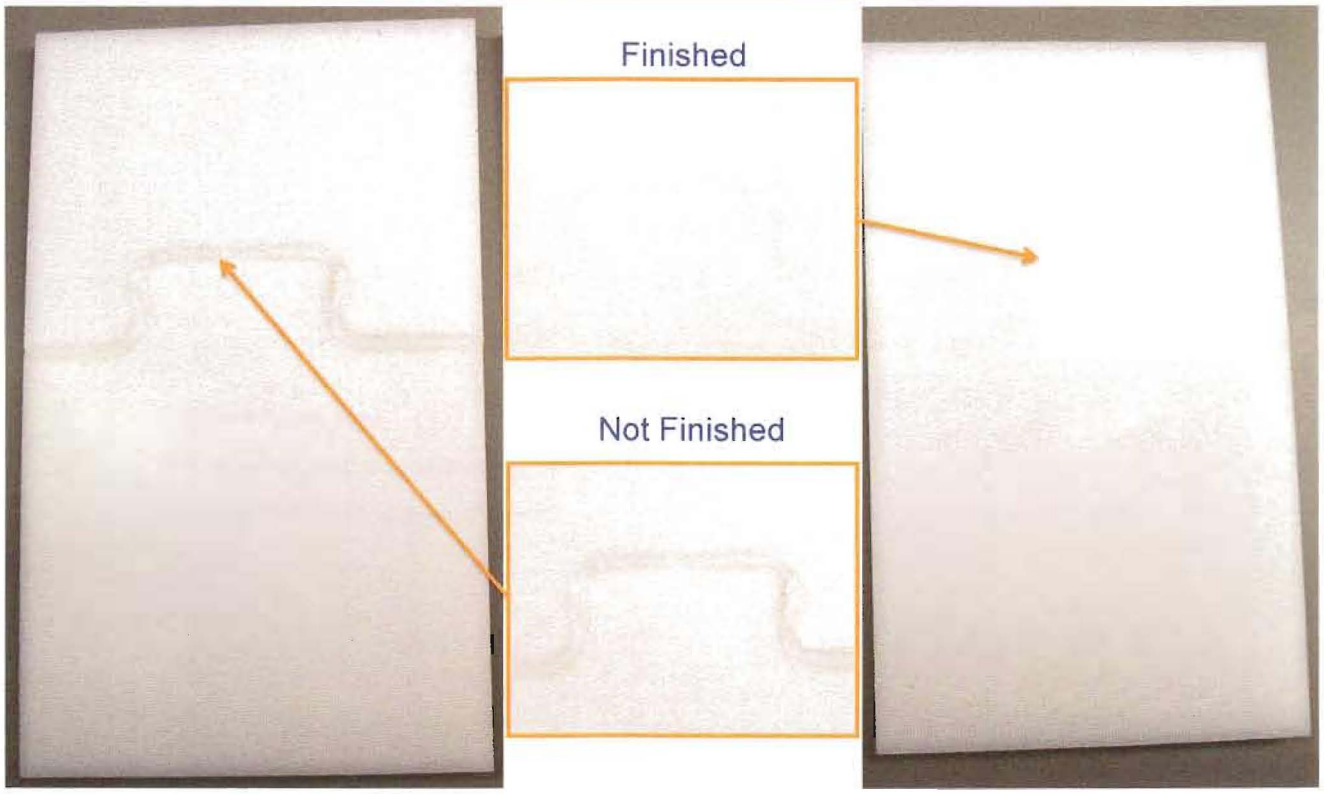
- Align joint and tack weld the entire part to avoid clamping
- Weld joint
  - Use desired filament as welding rod
  - Set the welder to the desired settings
  - Heat joint and filament and push along joint
  - Keep moving to avoid burning material
  - May need to make multiple passes to fill gap
- Finish joint
  - Sand smooth by hand or power sander
  - Fill any low spots with material and sand smooth

Bonding - Hot Air Welding

Hot Air Tool Temperature and Fan Speed Settings		
Material	Temp Setting	Fan Speed
ABS-M30 (all colors)	2.5	2.5
ABSi (all colors)	2.0	2.5
PC	2.5	2.5
PC-ABS	2.5	2.5
PPSF	5.0	3.0
ULTEM-9085		

Optional supplier: Leister Hot Jet S hot air tool from Malcom Company (www.malcom.com)

Bonding - Hot Air Welding



Secondary Post-Processing Overview

- Painting
- Sealing
- Plating
- Mass finishing
- Smoothing Station

Painting

- Display models
- Low volume production
- Custom products
- Pilot projects
- End use parts

- Considerations
  - Materials – ABS-M30 and legacy ABS are easiest to finish
  - Slice height - Finer slice height = less finishing
  - Orientation - minimize stepping on curved slightly surfaces

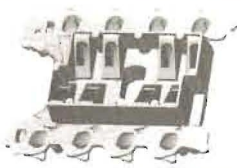
Painting Process

- Make sure part is free of dirt and oils
- Spray with light coat of primer
- Apply filler to areas where needed
- Wait for filler to cure
- Sand part
- Clean with wax and grease remover
- Apply first coat of primer
- Check for imperfections
- Repeat as necessary

Sealing

- Functional testing applications
- Low volume production 1-500 pcs.
- Performance characteristics meet specs
  - Sealing pressure
  - Chemical, thermal resistance
- Epoxy coating process
  - Two part epoxy
  - Brushed on part in small sections
  - No investment in equipment
  - Coating will remain airtight up to 65 psi (448 kpa)

FDM Manifold for Functional Testing



CAD model showing internal features

Production Manifold

Sealing Process

- Epoxy infiltration
  - Two part epoxy
  - Penetrates the surface of porous/semi porous parts
  - Parts immersed in resin and vacuum chamber to draw
  - Oven needed to pre-heat and cure the epoxy
  - Remain air and water tight up to 65 psi (448 kpa)

FDM Manifold for Functional Testing

Plating

- Increased mechanical properties
- Flight ready aerospace parts
- EMI shielding
- End use parts / aesthetics

- Consult with vendor on process specifics, estimate coating thickness, temperature exposed and other variables. Choose the right FORTUS material and adjust part according to vendor specifications

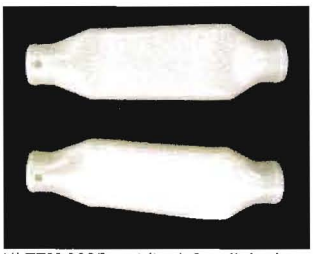
Plating Process

- Before building part - adjust CAD file to compensate for thickness of plating
- Sand surfaces to remove layer lines and stepped surfaces
  - Coarse sanding 120-220 grit
- Seal surfaces
  - Option 1 finishing station
  - Option 2 solvent dipping
  - Option 3 epoxy coating
- Allow part to cure - if using solvents allow minimum of 18 hours
- Re-sand surfaces
  - Sand any remaining layer lines or stepped surfaces
  - Wet sand with 500-1200 grit
  - Repeat until free of defects

Note: minor flaws must be buffed out of the copper coating before nickel is applied

Mass Finishing

- Centrifugal barrel or vibratory tub
- Typically used for higher volumes (> 25 pieces)
- Compensate for material removal when precision is needed (0.0015 – 0.0030 in. (0.04 – 0.08 mm) per surface)
- Benefits
  - Hands-free surface smoothing and polishing
  - Consistent quality
  - No harsh chemicals or solvents
  - Compatible with all Stratasys materials & platforms



ULTEM 9085: cut (top) & polished

Dental models: raw (left) & polished

Mass Finishing

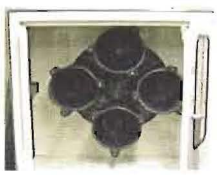
ULTEM 9085 duct: polished (left) & cut

Mass Finishing

Dental models: raw (left) & polished

Mass Finishing - Centrifugal Barrel

- Smooth fragile parts without damage
- Versus vibratory tubs
  - Shorter processing time
  - Less facility space needed
  - Less media
  - Quieter
  - Parts less than 5 x 5 x 5 in. (127 x 127 x 127 mm)
- Select machine with variable drive speeds
- Need access to water supply and drain



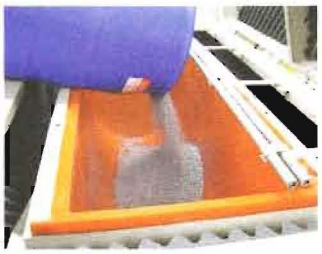
Turret

Loading media in barrel

Barrel holds part and media

Mass Finishing - Vibratory

- Fragile parts may be damaged due to weight of surrounding media
- Vibratory compared to centrifugal barrel
  - Smoothing within bores
  - Larger capacity
  - Bowls (smaller parts, less aggressive) or tubs (large parts, more aggressive)
  - Longer processing times
  - Very loud
- Select machine with variable drive speeds
- Need water supply line and drain
- Most machines need 3-phase power


Loading media


Parts and media in tub

Mass Finishing - Media Types

- Ceramic: most aggressive
  - Cutting or polishing
  - Best suited for PC, PPSF, & ULTEM
- Plastic less aggressive
  - Lighter, more media per pound
  - Best for ABS materials, but suitable for all
- Synthetic: less aggressive
  - Cleaner finishes (low residue)
  - Longer life (more wear resistant vs. plastic)
- Corncob: least aggressive
  - Polishing and gentle cutting
  - Best suited for ABS materials

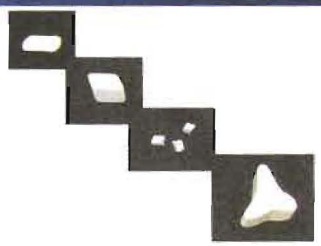

Ceramic angle-cut cylinders


Plastic cones


Corncob

Mass Finishing - Media Shapes

- Hard-edged with flat surfaces
  - Greater cutting action
  - More likely to nick or gouge
  - Examples: pyramids, triangles, tri-stars and blocks
- Soft-edged with round surfaces
  - Less cutting action
  - Better cutting of holes, bores, etc.
  - Less likely to lodge in features
  - Examples: cones, cylinders and ellipses
- Use a size smaller than smallest negative feature
- Can combine different shapes and sizes



Varied shapes and sizes

Finishing Touch™ Smoothing Station

- Low volume (typically less than 100 pieces)
- Seal surfaces at ambient pressures
- Fast, simple process
- Minimize labor
- Retains part accuracy +/- .0009in (.023mm)
- Applicable to ABS materials (ABS, ABSi, ABS*plus*, ABS-M30, and ABS-M30i)
- Parts may blister at temperatures at or above 176 ºF (80 ºC)

Finishing Touch™ Smoothing Station

Smoothing Chamber

- 13 x 16 x 20 inches (330 x 406 x 508 mm)

How it works

- Two chambers: one for cooling and curing, the other for smoothing
- Smoothing agent is heated to a vapor
- Vapor confined to the machine by cooling coils


Part suspended in vapor smoothing chamber


Sand pattern to smooth finish

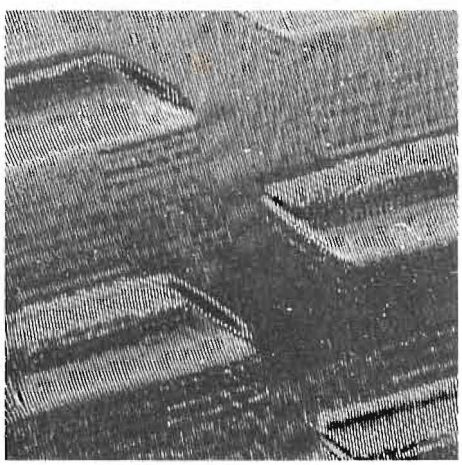
Finishing Touch™ Smoothing Station

Process

- Part placed in the cooling chamber
- Part transferred from cooling chamber to smoothing chamber for 10-30 seconds
- Part then hung to cure 15-20 minutes
- Lightly sand (optional) and repeat as necessary
- To achieve matte finish use sand blasting cabinet
  - Minimum working area of 40 x 22 x 20 inches (1016 x 509 x 508 mm)
  - POLYHARD type III bead media 20/30 bead screen size .841-.595 mm (.0331-.0234 inches)

Finishing Touch™ Smoothing Station

Before Smoothing



After Smoothing

Finishing Touch™ Smoothing Station

- Paint ready parts
  - Allow 12-18 hours fully cure before priming and painting
- Master pattern prep
  - Investment casting
  - Sand casting
  - RTV/silicone molding
- Sealing
  - Seal and smooth surfaces exposed to vapor
- Electroplating
  - Smooth and seal the parts

More Information

For more information see the Stratasys Resource Site, Product Resources tab.

https://www.stratasys.com/Single-Sign-On/Login.aspx